Original Research Article

Multicenter Study of the Impact of COVID-19 Shelter-In-Place on Tertiary Hospital-based Care for Pediatric Neurologic Disease

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Abstract

Objective: To describe changes in hospital-based care for children with neurologic diagnoses during the initial 6 weeks following regional Coronavirus 2019 Shelter-in-Place orders.

Methods: This retrospective cross-sectional study of 7 US and Canadian pediatric tertiary care institutions included emergency and inpatient encounters with a neurologic primary discharge diagnosis code in the initial 6 weeks of Shelter-in-Place (COVID-SiP), compared to the same period during the prior 3 years (Pre-COVID). Patient demographics, encounter length, and neuroimaging and electroencephalography use were extracted from the medical record.

Results: 27,900 encounters over 4 years were included. Compared to Pre-COVID, there was a 54% reduction in encounters during Shelter-in-Place. COVID-SiP patients were younger (median 5 years vs 7 years). The incidence of encounters for migraine fell by 72%, and encounters for acute diagnoses of status epilepticus, infantile spasms, and traumatic brain injury dropped by 53%, 55%, and 56%, respectively. There was an increase in hospital length of stay, relative utilization of intensive care, and diagnostic testing (long-term electroencephalography, brain MRI, and head CT (all $P<.01$)).

Conclusion: During the initial 6 weeks of SiP, there was a significant decrease in neurologic hospital-based encounters. Those admitted required a high level of care. Hospital-based neurologic services are needed to care for acutely ill patients. Precise factors causing these shifts are unknown and raise concern for changes in care seeking of patients with serious neurologic conditions. Impacts of potentially delayed diagnosis or treatment require further investigation.

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Keywords
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Introduction

The rapid spread of Coronavirus 2019 (COVID-19) disease caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) was declared a global pandemic on March 11, 2020.[1] In mid-March, regional Shelter-in-Place (SiP) orders including recommendations to avoid elective hospitalizations went into effect worldwide to decrease disease transmission and alleviate pressure on healthcare systems.[2]

Trends toward reduction in utilization of hospital-based care, including emergency department visits[3] and trauma activations,[4] were observed during SiP orders. Despite this national trend, the effect of SiP orders on hospital-based care utilization for neurologic diagnoses in children is unknown. Also, the ramifications of SiP orders across demographic groups remain to be determined.

We aimed to determine the effects of SiP on the number and demographic composition of children presenting to pediatric tertiary care hospitals with a primary neurologic diagnosis, and to determine the effects of SiP on hospital resource use and length of stay. We hypothesized that SiP orders would result in decreased hospital encounters for pediatric neurologic diagnoses compared to prior years, and that the change would vary by diagnosis, and severity of illness, and patient demographics.

We describe characteristics of patients with primary neurologic conditions who accessed hospital-based care during the initial 6 weeks of regional SiP orders beginning in March 2020 compared to the same periods of time during 2017, 2018, and 2019.

Methods

Sites and Encounters

This was a multicenter retrospective cross-sectional study conducted by the Pediatric Neurohospitalist Work Group (Table A1), a consortium of 7 pediatric tertiary care centers in the US and Canada dedicated to improving the quality of inpatient child neurology care.[5] Children's hospitals included the following: Nationwide Children's Hospital (Columbus, OH), Doernbecher Children's Hospital (Portland, OR), Benioff Children's Hospitals (San Francisco and Oakland, CA), Children's Hospital of Philadelphia (Philadelphia, PA), Children's Hospital Colorado (Aurora, CO), The Hospital for Sick Children (Toronto, Canada), and Children's National Medical Center (Washington, DC).

Electronic medical record systems were queried for emergency department (ED) and inpatient admission encounters that occurred during the initial 6 weeks of each institution's regional Shelter-In-Place order beginning in March 2020, referred to as the *COVID-SiP Cohort*, and the corresponding 6-week periods during the prior 3 years (2017, 2018, and 2019), referred to as the *Pre-COVID Cohort*. The 6 week period was chosen due to maximal disruption to the usual use of the acute health care system. Start dates for Shelter-in-Place were defined as the date the local order began for each institution and ranged from 3/16/2020 to 4/1/2020. Data for prior years included the same calendar dates for each institution in 2017, 2018, and 2019. Encounters were included if the primary discharge diagnosis was 1 from a predetermined list of neurologic diagnoses from the International Classification of Diseases Tenth revision (ICD-10)[6] (Supplementary Table 1). An encounter was defined as an ED visit, or hospital admission of any length of stay.

Sixteen ICD-10 Disease Lead Terms were assigned to 5 disease categories: Infection/Inflammation, Epilepsy, Migraine, Stroke/Vascular, and Traumatic Brain Injury (Supplementary Table 1).

Variables

Clinical and demographic variables were extracted from the medical record. These included age, sex, race, ethnicity, admission and discharge dates, discharge unit (ED or inpatient), days in an Intensive Care Unit (ICU), and diagnostic procedures (routine and long-term electroencephalograms (EEGs), brain MRI, spine MRI, and head CT). One institution was limited by their local Institutional Review Board to providing a subset of diagnostic and demographic information including sex, race, and ethnicity.

Statistical Analysis

When analyzed by location of service, encounters were assigned to "ED Discharge" or "Inpatient Discharge" categories. ED Discharge encounters include patients discharged from the ED. Inpatient Discharge encounters include patients that were admitted from the ED, directly admitted from another health care setting, or directly admitted from home.

Statistical analyses were performed using Stata/MP 15 (StataCorp, College Station, TX). Descriptive statistics were used to summarize each cohort's characteristics. Differences in demographic and clinical characteristics in the Pre-COVID and COVID-SiP cohorts were evaluated with Mann–Whitney U test for continuous variables and Pearson's chi-squared test for categorical variables. For each disease category, incidence was calculated as the number of cases per the 6-week study period for each year. Incidences were then grouped into Pre-COVID (2017–19) and COVID-SiP (2020). Poisson regression was used to assess the difference in the incidence of

Table 1. Complete Cohort Demographics, n (%) (total N = 27,900).

	Pre-COVID			COVID-SiP
	2017 (n = 8088)	2018 (n = 8053)	2019 (n = 8028)	2020 (n = 3731)
Age (years), median (IQR)	7 (2–13)	7 (2–13)	7 (2–13)	5 (1.7–12)
Sex				
Female	3175 (39.2)	3095 (38.4)	3295 (41)	1471 (39.4)
Male	3599 (44.5)	3660 (45.4)	3501 (43.6)	1691 (45.3)
Unknown/missing	1314 (16.2)	1298 (16.1)	1232 (15.3)	570 (15.2)
Race				
American Indian or Alaska Native	25 (.3)	18 (.2)	22 (.2)	8 (.2)
Asian	182 (2.2)	199 (2.4)	214 (5.6)	88 (2.3)
Black	1918 (23.7)	1873 (23.2)	1845 (22.9)	740 (19.8)
Native Hawaiian or Other Pacific Islander	16 (.2)	21 (.2)	14 (.1)	3 (.08)
Other	1383 (17.1)	1290 (16)	1442 (18)	636 (17)
White	3118 (38.5)	3199 (39.7)	3098 (38.5)	1577 (42.2)
Unknown/declined	1446 (17.8)	1453 (18)	1393 (17.3)	679 (18.2)
Ethnicity				
Hispanic or Latino	1370 (17)	1385 (17.2)	1438 (18)	665 (17.8)
Not Hispanic or Latino	4490 (55.5)	4397 (54.6)	4302 (53.5)	2089 (56)
Unknown/not reported	2228 (27.5)	2271 (28.2)	2288 (28.5)	977 (26.1)
Discharge unit				
Emergency department	5535 (68.4)	5656 (70.2)	5545 (69)	2458 (65.8)
Inpatient unit	2553 (31.5)	2397 (29.7)	2483 (31)	1273 (34.1)

Abbreviation: IQR = interquartile range.

each disease category between Pre-COVID and COVID-SiP. The data are presented as incidence ratios between Pre-COVID and COVID-SiP with 95% confidence intervals. Model diagnostics included deviance goodness-of-fit and Pearson goodness-of-fit. Both tests indicated good model fit for all disease categories except for infection/inflammation for which negative binomial regression was used instead of Poisson regression. To perform race and ethnicity group comparisons between the pre-COVID and COVID-SiP cohorts, we used multinomial logistic regression. The outcomes of interest were race and ethnicity as categorical variables, with White race being the base outcome for race, and non-Hispanic or Latino being the base outcome for ethnicity. Covariates included Pre-COVID vs COVID-SiP, and site location. Data is presented as relative risk ratios with 95% confidence intervals. Hospital and ICU length of stay were highly right-skewed with values concentrated around the median. Therefore, differences in length of stay were analyzed using Wilcoxon Rank-Sum test. All reported *P*-values are two-sided and the threshold for statistical significance was set at an alpha of .05.

Standard Protocol Approvals, Registrations, and Patient Consents

This study was approved by each site's local Institutional Review Board. Consent was waived due to the de-identified nature of the data.

Results

Seven pediatric tertiary care hospitals including 2 eastern US, 2 midwestern US, 2 western US, and 1 Canadian hospital participated in this study. Hospitals have an average of 424 inpatient beds (range 145–673), 56 ICU beds (range 25–75), and an average ED volume of 87,921 encounters per year (range 15,000–168,394).

Pre-COVID and COVID-SiP Cohort Characteristics

A summary of the demographic characteristics of the total cohort is presented in Table 1. A total of 27,900 encounters including 24,169 Pre-COVID encounters (8088 in 2017, 8053 in 2018, and 8028 in 2019) and 3731 COVID-SiP encounters were included. Figure 1 shows the number of encounters per year, stratified by disease category and by ED vs inpatient discharges. There was a 54% reduction in COVID-SiP encounters compared to the average number of Pre-COVID encounters. Among the 7 hospitals, the reduction ranged from 38 to 62%. COVID-SiP patients were younger with a median age of 5 years (IQR 1–12 years) compared to the Pre-COVID median age of 7 years (IQR 2–13 years, $P < .01$) (Supplementary Table 2). After adjusting for hospital location, the relative risk for each subject of belonging to a certain racial (White vs non-White) or ethnic (Latino vs non-Latino) group was similar for those in the COVID-SiP cohort relative to the Pre-COVID cohort (Supplementary Table 3).

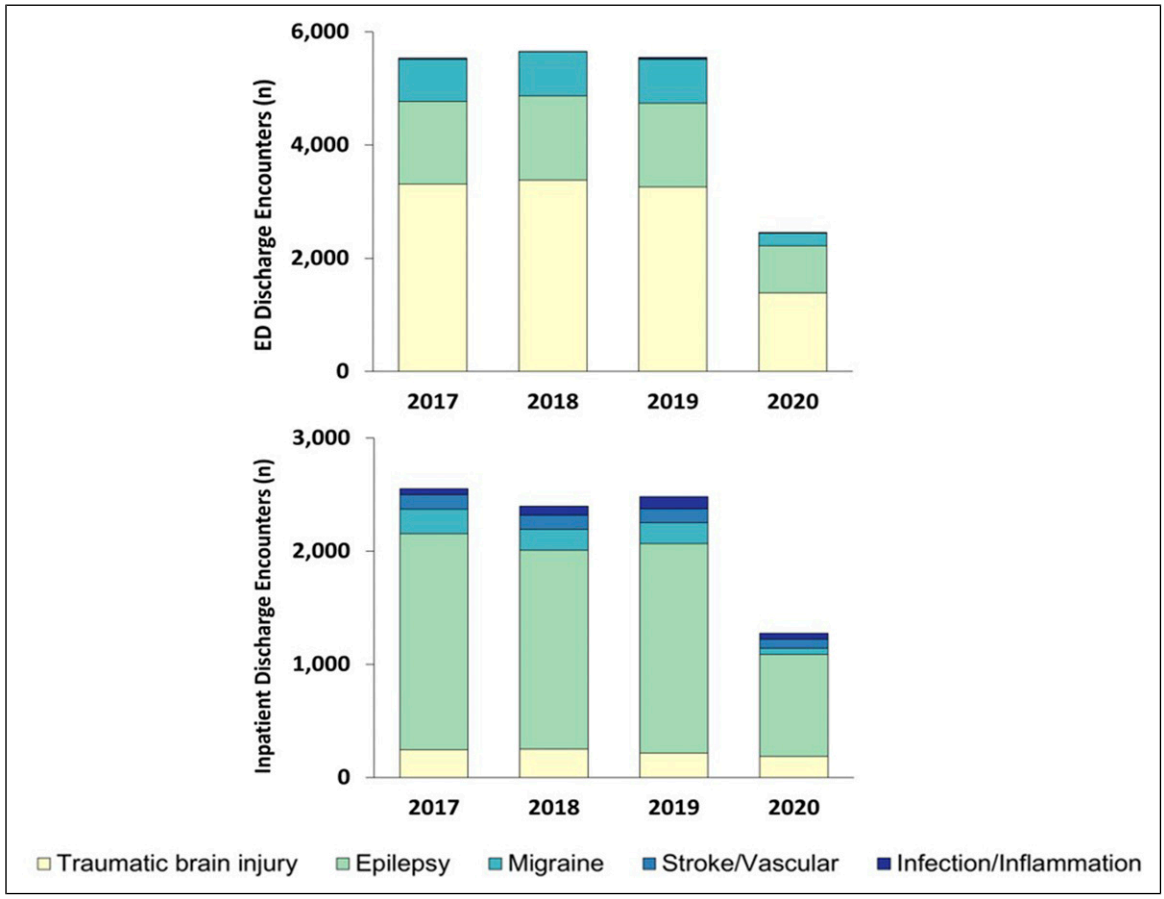

Figure 1. Number of emergency department and impatient discharge encounters, stratified by year and disease category.

Pre-COVID and COVID-SiP Encounters by Diagnosis Category

In the COVID-SiP cohort, there was a significant decrease in the incidence of encounters with a primary discharge diagnosis in the categories of epilepsy (48% reduction), migraine (72% reduction), stroke/vascular (34% reduction), and traumatic brain injury (56% reduction) as compared to the Pre-COVID cohort (all *P*-values <.01, Table 2). Within the epilepsy category, in the COVID-SiP cohort there was a 53% reduction in the incidence of encounters for status epilepticus (P < .01) and a 55% reduction in the incidence of encounters for infantile spasms (P < .01) compared to the Pre-COVID cohort (Table 2).

Pre-COVID and COVID-SiP Diagnostic Testing and Hospital Resource Utilization

Diagnostic Tests. Despite an overall decrease in the absolute numbers of EEG, and neuroimaging (Table 3), in the COVID-SiP cohort, there was a significant increase in the percentage of inpatient encounters associated with a long-term EEG monitoring code (26.8% vs 22.2% Pre-COVID, P < .01). The percentage of encounters associated with a routine EEG code was unchanged. In the COVID-SiP cohort, there was a significant increase in the percentage of encounters associated with a brain MRI code, both in the ED (2.6% vs 1.6% Pre-COVID, P < .01) and inpatient discharges (32.2% vs 19.1% Pre-COVID, P < .01). There was a significant increase in the percentage of encounters associated with a spine MRI code in the COVID-SiP cohort, both in the ED (.2% vs .06% Pre-COVID, P = .03) and inpatient discharges (5% vs 2.7% Pre-COVID, P <.01). There was a significant increase in the percentage of encounters associated with a head CT code in the COVID-SiP cohort, both in the ED (12.3% vs 7.7% Pre-COVID, *P* value <.01) and inpatient discharges (28.4% vs 18.1% Pre-COVID, *P* value <.01) (Table 3).

Admissions to the Pediatric Intensive Care Unit and Hospital Length of Stay. In the COVID-SiP cohort, patients were more likely to be admitted to an inpatient unit (34.1% vs 30.7% Pre-COVID) and less likely to be discharged from the ED (65.8% vs 69.2% Pre-COVID) (P < .01) (Table 1). Among COVID-SiP patients admitted to the hospital, the percentage of encounters associated with an ICU admission increased significantly (79% vs 71% Pre-COVID, P < .01, Table 4).

Table 2. Incidence of Neurologic Encounters Per Year, Stratified by Disease Category.

	Incidence (cases/study period)		Incidence ratio	95% CI	*P*-value*
	Pre-COVID mean (SD)	COVID-SiP			
Infection/inflammation	88 (32)	51	.58	.31–1	.08**
Epilepsy	3314.3 (64)	1732	.52	.5–.54	**<.01**
Status epilepticus	253.3 (11)	120	.47	.39–.57	**<.01**
Infantile spasms	70 (7)	32	.45	.31–.66	**<.01**
Migraine	961.3 (6)	278	.28	.25–.32	**<.01**
Stroke/vascular	139 (10)	92	.66	.52–.82	**<.01**
Traumatic brain injury	3554 (80)	1578	.44	.42–.46	**<.01**

*Poisson regression, unless noted otherwise.
**The incidence of infectious/inflammatory diagnoses does not follow a Poisson distribution, so negative binomial regression was used.
Bold: statistically significant at the .05 level; Abbreviations: CI = confidence interval; SD = standard deviation.

Table 3. Hospital Resource Utilization.

	Emergency department discharges			Inpatient discharges		
Resource, n (%)	Pre-COVID n = 14,114	COVID-SiP n = 2082	*P*-value*	Pre-COVID n = 6211	COVID-SiP n = 1081	*P*-value*
EEG routine	44 (.3)	9 (.4)	.36	2541 (41)	450 (41.6)	.65
Long-term EEG monitoring	37 (.2)	4 (.2)	.55	1383 (22.2)	290 (26.8)	**<.01**
MRI brain	227 (1.6)	56 (2.6)	**<.01**	1186 (19.1)	349 (32.2)	**<.01**
MRI spine	8 (.06)	4 (.2)	**.03**	170 (2.7)	55 (5)	**<.01**
CT head	1088 (7.7)	258 (12.3)	**<.01**	1128 (18.1)	308 (28.4)	**<.01**

*Pearson's chi-squared test.
Bold: statistically significant at the .05 level.; Abbreviations: EEG = electroencephalogram; MRI = magnetic resonance imaging; CT = computed tomography.

Table 4. Admission Length of Stay and Intensive Care Unit Utilization for Hospital Admission Encounters only.

	Pre-COVID n = 7433	COVID-SiP n = 1273	*P*-value
Intensive care unit admissions, n (%)	5285 (71)	1006 (79)	**<.01***
Hospital length of stay, days, median (IQR)**	2 (1–4)	2 (1–5)	**<.01*****
PICU length of stay, days, median (IQR)	0 (0–.7)	0 (0–1)	**<.01*****

*Pearson's chi-squared test,
**Length of stay was missing data for 615 patients.
***Wilcoxon Rank-Sum test.
Bold: statistically significant at the .05 level.; Abbreviations: IQR = interquartile range; PICU = Pediatric Intensive Care Unit.

The hospital length of stay was longer in the COVID-SiP cohort (hospital length of stay (days), median [IQR]: 2 [1–4] Pre-COVID vs 2 [1–5] COVID-SiP, P < .01, Table 4). The ICU length of stay was longer in the COVID-SiP cohort (PICU length of stay (days), median [IQR]: 0 [0–.7] Pre-COVID vs 0 [0–1] COVID-SiP, P < .01, Table 4).

Discussion

In this multicenter cross-sectional cohort study, we found that in the initial 6 weeks after regional COVID-19 SiP orders beginning in March 2020, 54% fewer pediatric patients used hospital-based care for common neurologic diseases compared to the same 6-week periods in the prior 3 years. Patients accessing care during SiP were younger. Nearly all neurologic disease categories studied had a decreased incidence during SiP; however, migraine and traumatic brain injury were the most impacted. Interestingly, encounters decreased for diagnoses that included neurologic emergencies, for example, stroke/vascular diagnoses, status epilepticus, and infantile spasms. Despite an overall decrease in encounters, the COVID-SiP cohort required a proportionally higher level of care as evidenced by higher rates of hospital admissions, an

increased proportion of encounters with admission to the ICU, longer hospital length of stay, and a higher rate of diagnostic procedures including long-term EEG monitoring, brain and spine MRI, and head CT.

Studies have found that the use of healthcare services for both non-acute and acute conditions decreased in the early months of 2020.[3,7-9] Our findings expand the understanding of the impact of SiP orders to the pediatric population with primary neurologic diagnoses. However, there have also been reports of increased pediatric presentations to acute care settings during SiP orders including increases in the incidence of pediatric physical child abuse[10] and acute burn admissions.[11] The reasons for these disparate findings are complex and involve both disease-related and psychosocial factors. A sudden and significant care shift towards telemedicine during the pandemic was widely promoted and adopted at the clinical and policy level,[12,13] including for management of chronic and non-acute neurologic conditions,[14,15] such as migraines or break-through seizures. More research is needed to determine if patients with non-acute diagnoses preferentially sought care through outpatient or telehealth avenues over hospital-based settings during this study period, and to understand how patient outcomes were impacted by this change in care model. If patient satisfaction and health outcomes were maintained, then the care pathways adapted and adopted during the pandemic could demonstrate long-term effects of reducing emergency room utilization and hospital admissions for non-acute conditions.

However, our study also shows a significant reduction in presentation to pediatric hospitals for serious or life-threatening conditions such as traumatic brain injury, status epilepticus, stroke/vascular diagnoses, and infantile spasms. Previous work has described a decrease in emergency healthcare utilization for life-threatening conditions during the pandemic such as coronary artery disease,[16] including an increase in time from myocardial symptom-onset to hospital-arrival.[17,18] Although stroke alert volumes decreased, patients presenting with stroke during SiP had higher stroke severity scores and less frequently had stroke mimics.[19] Our findings are consistent with this existing literature and raise the concern that during SiP, some patients experiencing serious and even life-threatening conditions may have avoided seeking emergency care or potentially were advised to stay home by a health care provider. Follow up studies should investigate if the decrease in hospital-based encounters resulted in worse outcomes from delayed diagnosis or treatment, or whether patients appropriately avoided unnecessary evaluation, treatment, and potentially iatrogenic-related harm. Future studies including longitudinal assessment of trends in Emergency Department encounters that required only education and outpatient management vs encounters needing intravenous medications or diagnostic studies may help identify patients that could benefit from increasing access to ambulatory care models including virtual care.

Possible explanations for the decrease in incidence of neurologic emergencies include the following: (1) strict adherence of patients to SiP orders or advice from providers to not present to care, (2) the economic and social impacts of the pandemic caused barriers to accessing care, or (3) incidence of some conditions may have decreased during this time period. Infection is a risk factor for both pediatric stroke[20-22] and status epilepticus.[23,24] The decrease in encounters for these diagnoses could reflect an overall decrease in exposure to typical childhood viral illnesses. Additionally, common provoking factors for seizures and status epilepticus including poor sleep and medication adherence challenges could have improved when children were out of school and home with caregivers more consistently. Common etiologies for infantile spasms include structural and genetic causes,[25] and typically inpatient admissions are pursued to facilitate prompt diagnosis and treatment.[26] Delayed diagnosis of infantile spasms has been described in resource limited settings.[27] Concerns regarding inpatient hospitalizations during the pandemic to diagnose and treat infantile spasms were acknowledged in an online Child Neurology Society statement[28] and later formalized into published recommendations.[29] Recommendations include utilizing outpatient telemedicine, home videos of patient events, outpatient EEGs and MRIs, and preference for oral prednisolone over ACTH for ease and safety of initiation in the outpatient setting. This formal recommendation may account for a portion of the decrease in infantile spasm encounters. However, the possibility of decreased recognition, referral, and diagnosis leading to delayed treatment warrants further investigation.

Several factors could have contributed to the lower median age of the COVID-SiP cohort. Caregivers of younger patients may have heightened concern given younger children are not able to communicate their symptoms as readily, ambulatory care teams may have a lower threshold for recommending that younger children be evaluated in person, and caregivers may have felt more comfortable avoiding the emergency department for older patients with more established home care regimens than for younger children with new or more recent diagnoses.

We analyzed severity of illness by measuring rates of hospital and ICU admissions, length of admission, and use of neuro-diagnostic tests. As compared to the Pre-COVID cohort, the COVID-SiP patients had proportionally more ICU admissions, longer hospital admissions, and a higher proportion of encounters were associated with neuro-diagnostic tests. Contributing factors are likely multifactorial including children with less acute conditions not presenting to care as they may have previously, as well as increased severity of

illness potentially in part due to delay to presentation. It is also possible that availability of diagnostic testing was increased during SiP due to fewer elective or outpatient neurodiagnostic studies during this time. Although this analysis found a statistically significant difference in hospital length of stay, the medians are the same for the Pre-COVID and COVID-SiP cohorts (median 2 days, Table 4). This minimally clinically meaningful statistical difference could be due to the large data set. However, given bed and staffing constraints among children's hospitals in late 2021,[30-32] these small differences over thousands of encounters could be clinically significant and impact inpatient delivery of care. These data support the need for preserved and continuous staffing of hospital-based neurologic services to care for acutely ill patients during the current pandemic and potential similar future challenges to our healthcare system.

Our findings are of particular interest to those practicing pediatric medicine in the inpatient and outpatient settings. A decrease in emergency department visits would be expected to increase care sought in the ambulatory setting, either through visits to primary care providers or outpatient specialists, in person or through telemedicine. The repercussions of this shift towards ambulatory care are unknown, but anecdotally the shift imposed strains on ambulatory services. Many neurologic conditions do necessitate an expedited, comprehensive, and collaborative approach of a hospital-based team and diagnostic resources. At a time when patients and providers want to "avoid the emergency room," our data may serve to remind primary care doctors and triaging clinicians to ensure that children receive the right care, in the right place, at the right time.

The overall trends in hospital-based care utilization for pediatric patients with neurologic disease persisted across all 7 participating institutions, including 1 non-US site, which has a different model of health care delivery, thereby enhancing the generalizability of our findings. By analyzing the matched time period in the prior 3 years (2017-2019), we were able to ensure that the number of encounters stratified by location and diagnosis was stable over the 3 years preceding the pandemic, therefore ensuring the validity of the post-pandemic changes.

The generalizability of these findings is affected by the short study period early in the pandemic when relatively little was known regarding this novel coronavirus including infection control. Given the non-standard nature of billing code use, reliance on ICD-10 discharge codes entered by a variety of medical professionals at the time of each encounter may have led to an overestimate or underestimate of the cohort size. For example, discharge codes may reflect a patient's pre-existing neurologic diagnosis and not their reason for current admission. However, by using time-period matched cohorts from the same institutions in the prior 3 years, we expect the same biases and patterns of assigning billing codes persisted at the institutional level. The size of the cohort prevented detailed chart review to verify diagnosis codes. Selected ICD-10 codes did not capture all patients with neurologic disorders. For example, codes for multiple sclerosis and transverse myelitis were not included. These are relatively low volume conditions and future studies may target admission trends for these conditions. Additional limitations include lack of data on total emergency department usage during the same time frame and inability to determine if there were changes to criteria or threshold for admission. Our analysis focused on presentations to the tertiary hospital and did not assess differences in patient presentations to community hospitals and changes in trends in transferring patients to tertiary care.

Conclusion

COVID-19 SiP orders in the spring of 2020 impacted hospital-based care for pediatric patients with neurologic diagnoses. Encounters decreased by 54% compared to the same period during the prior 3 years, and this trend occurred for all 7 US and Canadian institutions and nearly all categories of neurologic disease. This study raises questions regarding the reasons underlying these trends including complex changes in the overall incidence of disease, economic impacts of the pandemic, and fear of exposure to the coronavirus causing COVID-19. Although this study was designed to look at an unprecedented time in history, these findings are applicable to any public health crisis, stress on the acute care system, or other resource limited scenario. Efforts should be made to ensure consistent access to acute care. The effect of potentially delayed diagnosis or treatment of neurologic emergencies has yet to be determined. Innovations in care models that supported a shift to ambulatory care and telemedicine may have a longer impact and benefit in caring for patients where emergency care was previously sought. In our study patients admitted to the hospital during SiP required a high level of care, a finding that supports the need for uninterrupted hospital-based neurologic services to care for acutely ill patients. Longitudinal studies are needed to determine if the changes were isolated to the study period or have persisted, and how they will shape child neurology inpatient and outpatient practices long-term.

Appendix 1

Table A1. Pediatric Neurohospitalist Work Group Members.

Name	Location	Role
Melissa L. Hutchinson, MD, MA	Nationwide Children's Hospital, the Ohio State University, Columbus, OH	Site investigator, lead study coordinator
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Jamie Palaganas, MD	Weill Cornell Medicine, New York Presbyterian Hospital, New York, NY	Site investigator
Elizabeth Wells, MD	Children's National Hospital, George Washington University School of Medicine and Health Sciences, Washington, DC	Site investigator
Craig A. Press, MD, PhD	Children's Hospital of Philadelphia, University of Pennsylvania, Philadelphia, PA	Site investigator
Juan Piantino, MD, MCR	Doernbecher Children's Hospital, Oregon Health and Science University, Portland, OR	Site investigator, data center manager

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Data Availability

The data that support the findings of this study are available upon request and approval through the Pediatric Neurohospitalist Work Group

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Supplemental Material

Supplemental material for this article is available online.

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